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U.S. DEPT. OF AGRICULTURE

United States
Department of
Agriculture

Forest Service

**Intermountain
Forest and Range
Experiment Station
Ogden, UT 84401**

Research Note
INT-328

April 1983

Bulldozers in Fire Management: Current Designs and Uses

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ABSTRACT

Reports on status and changes in use of bulldozers in fire control and related applications throughout the United States among Federal and State agencies. Covers various applications, changes in use, and changes and improvements in machines. Fireline production rates for new machines appear to be significantly higher than data currently in use would indicate. No significant changes in dozer use have been noted. Environmental constraints and changes in wildfire suppression policies have been implemented locally.

KEYWORDS: bulldozers, fireline construction, fireline production rates, line construction, use changes, equipment changes

INTRODUCTION

Fire management planning requires up-to-date information about the capabilities of modern machines; in this case, the bulldozer. (A bulldozer is a crawler tractor pushing an attached blade, without a plow.) This paper examines changes in bulldozers during the past 20 years, assesses the current use of bulldozers for constructing firelines in the various regions of the United States, and assesses the need to update fireline construction rates.

Bulldozers are mainly utilized to cut fire lines to mineral soil in heavy forest fuels and logging slash. Hand crews usually cannot construct lines fast enough through these fuels. Dozers are also used to prepare firelines ahead of prescribed fires; such preparation is often part of a timber harvest where the same dozers also skid logs. Dozers are often used to augment the initial attack because they are generally available within reasonable cost. Fire suppression organizations may either own or contract for machines.

Use of bulldozers has been criticized and sometimes curtailed because of environmental concerns. Damage results primarily from erosion and even gully formations in fire trails, and sometimes sloughing of slopes where trails cross steep terrain. Soil compaction and disturbance of archeological sites are also concerns. Concern for the environment may reduce dozer use and encourage alternate methods of building firelines. Such concern could also increase construction time because the firelines often have to be longer and more carefully located. For example, instead of locating a fireline straight down a steep slope adjacent to a fire, the line might be moved to a more gentle slope, resulting in a line that takes longer to construct and secure.

No exact figures are available on curtailment of dozer use, but the State of Alaska, for example, requires special permission within its organizations before bulldozers can be used to construct firelines, particularly on areas underlaid by permafrost. Alternative ways of constructing firelines are considered instead of automatically ordering dozers when planning the initial attack on a fire. Firelines around logged areas, especially on steep slopes, are currently being built by hand, with explosives, or with retardants in an effort to reduce the wide scars left by bulldozers.

EXISTING BULLDOZER DATA

Data on rates at which dozers construct fireline vary in quantity and quality, depending on the precision of the studies and the section of the Nation. The USDA Forest Service is by far the largest source of information, which is most commonly found in various "Fireline Notebooks." These data were obtained, in most instances, from machines as they existed 15 to 25 years ago. The tabulated productivity data were found to vary widely for a given type of forest fuel and among forest regions. Unfortunately, the variations found cannot be explained on the basis of soil, slope, fuel type, or other considerations (Storey 1969). Variation makes it difficult to use the production data for accurate estimates of fireline construction rates under specific circumstances of site conditions, forest fuels, and machine sizes (weight and horsepower).

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Bulldozers are compared mainly by weight and horsepower. The manufacturing trend has been toward heavier machines for a given size class. The effects of increased weight and other mechanical changes have been assessed by querying dozer operators. Some significant mechanical changes in bulldozers are (1) hydraulic rather than manual controls, (2) torque converters, (3) increased speed, and (4) increased drawbar horsepower.

Table 1 compares the changes in several machines. The older machines, for which early production data apply, were classified by drawbar horsepower (hp) and varied from 55 hp for a Caterpillar D-6[2], classed as a medium-sized tractor, to 140 hp for an International TD-24, classed as a large-sized tractor. Today bulldozers are rated by flywheel horsepower (Fw hp), and vary from 140 Fw hp for a Caterpillar D-6D, classed as a medium-sized tractor, to 300 Fw hp for a Caterpillar D-8K, classed as a large-sized tractor. There is no formula for converting flywheel horsepower to drawbar horsepower because of the many combinations of gears and torque converters. This fact made it difficult to compare the older machines with the newer ones on the basis of horsepower rating; hence, the comparisons here are limited to broad classes such as medium and large.

Weight has increased considerably; however, handling and production capabilities have also improved, according to dozer operators. The basic drawbar horsepower has also increased appreciably. The addition of such features as hydraulic blade systems has made a much more efficient machine. Operators can change the blade angle without stopping or leaving the cab. Building fireline downhill is easier and safer because the hydraulic system will keep the blade in the soil and act as a brake. Under the old cable-controlled blade systems, operators working downhill could lose their load of soil and have a downhill runaway. The new design may have undesirable effects, such as deeper scarification.

Table 2 was constructed from both published and unpublished data in an attempt to compare production rates for tractors of similar sizes through fuels classified as light, medium, or heavy. The figures appearing here are averages and have been rounded off to the nearest whole number. Even this limited sample reflects a wide variation of production rates. Part of the variation, sometimes in excess of 300 percent, is probably due to differences between and within the broad fuel type classes, as well as the more specific situations where data were collected. Although variation is relatively large, it may also be real.

Recent mechanical improvements to bulldozers have added to the variability of production rates. Because of increased efficiency, greater power, and improved handling, the newer and larger machines can outperform their predecessors. The old performance data, especially when used in conjunction with current costs and machines, can give misleading figures regarding cost effectiveness in fireline production applications today.

Table 1.—Bulldozer weight comparisons (from manufacturers' specifications)

Make	Model No.	Weight	Horsepower class
		Lb	
Caterpillar	D-8	46,300	Large
	D-8K	70,500	
	D-7	33,500	Medium
	D-7G	44,300	
	D-6	22,500	
	D-6D	31,500	
International	TD-24	50,300	Large
	TD-25	71,000	
	TD-18	33,200	Medium
	TD-20	47,500	

Table 2.—Fireline construction rates (single pass) for large and medium dozers in various fuel types (resistance to control) and under average conditions

Data Source	Large Dozer			Medium dozer		
	Fuel type			Fuel type		
	Low	Medium	High	Low	Medium	High
	Chains per hour					
BLM Fireline Notebook (USDI 1969)	65	25	15	40	20	10
U.S. Forest Service Fireline Notebook (USDA 1963)	No data	47	41	No data	41	30
Montana State University (Steele 1961)	34	26	13	30	24	12
California Department of Forestry (1964)	86	92	62	No data	No data	No data
California Department of Forestry (1967)	80	50	40	70	60	20
National Wildfire Coordinating Group (1980)	90	43	35	60	30	20

BULLDOZER USE IN VARIOUS REGIONS

Although environmental concerns and changes in fire management philosophies have changed some applications, dozers remain an important tool. In some areas use may have increased, while in others alternative methods have been employed on occasion. Nevertheless, the dozer is still a very useful machine in many situations.

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[2] The use of trade, firm, or corporation names in this publication is for the information and convenience of the reader. Such use does not constitute an official endorsement of or approval by the U.S. Department of Agriculture of any product or service to the exclusion of others that may be suitable.

In the following sections, a brief summary of dozer applications throughout various forested regions is presented. Information was obtained through State and Federal fire management agencies. Although some of the reported use is not "soil pushing," on line-building described earlier, it is an application of crawler, tracked-type machinery. Also, future trends of bulldozer use have been indicated.

Southern States

(Alabama, Arkansas, Florida, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, South Carolina, Texas)

In the south, tractors are commonly used to pull plows. Dozers have push blades, too, but the plow is the chief tool of mechanized fireline building. The use is increasing somewhat due to new programs of prescribed fire and for fire prevention. Kentucky indicates, however, that dozers are too expensive and more pumper trucks are being used.

Northeastern States

(Maine, New Hampshire)

In the northeast, dozers are often used in conjunction with pumper trucks. The dozer use for fire suppression remains constant, but use for prescribed burning is increasing. No environmental constraints on dozer use are evident here, but land managers are being asked to consider alternatives.

Southwest

(New Mexico, Arizona, Utah)

In the southwest, bulldozer use, most popularly with Caterpillar D-7 and D-8 size categories, is increasing because of the difficulty of obtaining organized crews to construct firelines. There is also a need in this region to construct lines rapidly due to highly flammable fuels. Dozers are used for line construction in flashier fuels, especially where surface rock is not a problem. It has also been found here that bulldozer use is less costly than hand crews per chain of line. An attempt is being made, however, to reduce bulldozer use on prescribed fires.

Alaska

(Interior)

Bulldozer-constructed firelines cause extreme site damage, especially on permafrost areas. In order to minimize erosion damage, firelines are located to avert steep slopes and fragile sites underlaid by permafrost. This slows line construction and prevents building fireline adjacent to the burning fuels, which is so essential for good fire suppression practice. The damage from dozer-constructed firelines can be severe enough that special permission from supervisory personnel is needed before dozers may be used. The feeling here is that explosives or other alternatives should be used wherever possible to minimize environmental damage. Because of curtailed use, the need for more refined data on bulldozer construction rates does not seem of high importance in Alaska.

Pacific Northwest

(Oregon, Washington)

Bulldozers are in constant use for fire suppression in this geographic area because of heavy fuel complexes. Dozers are extensively used on large fires as the main line-building method. They are more likely to be used where fires have escaped initial attack, rather than during initial attack. Bulldozers are often used to reopen logging roads ahead of pumper units. Preconstruction of firelines around heavy slash concentrations is also a common application.

Rocky Mountains

(Colorado, Idaho, Montana)

Bulldozers are used extensively in this region for wildfire control. They are also used for constructing firelines around logged areas prior to prescribed burning. Use in wildfire suppression is increasing slightly because the cost appears to be lower than for aircraft and hand crews. This is especially true on private lands where environmental restrictions are less severe than on public lands, and where heavy monetary losses are feared. Dozers still comprise an integral part of initial attack planning and fireline construction. Reduced use on prescribed fires is evident because of environmental damage and because of esthetic considerations. Use has been reduced on some Federal lands mainly because of concern for soil damage.

Utah and Wyoming

Dozers are used whenever possible because of relatively low cost, low-value lands, and difficulty in obtaining volunteer firefighters. Prescribed burning of 10,000 acres annually has temporarily increased the use of dozers for preconstruction of firelines, but experimental use of wet-line techniques on management fires may eventually reduce tractor use.

California

Bulldozer use remains constant for constructing firelines and for constructing firebreaks along ridges and at other critical locations. An estimated 17,000 hours of annual use involving 55 State-owned machines is an indication of use. In California dozers are more commonly used for fireline construction than anywhere else in the United States.

Lake States and Midwest

(Michigan, Minnesota, Wisconsin)

Tractors with plow units are used exclusively here. Dozers with push blades alone are not a major fireline tool, though some units have both blades and plows.

General Comments

It is generally agreed in all forest regions that the environment must be protected from bulldozer scars. In most regions, managers agree that after fires are controlled, dozer trails should be treated to curtail erosion. All feel that some dozer use will probably be reduced. Locating dozer lines carefully on going fires can help reduce environmental damage, but fireline construction would also be slowed.

SUMMARY AND CONCLUSIONS

Bulldozer operators who have had experience with both old and new machines report significant improvements in performance. Both the controls and the blade-lifting mechanisms are hydraulically operated, which are significant improvements. Time-trial data are needed to substantiate the claims and quantify these differences. A study is needed to determine fireline construction rates for the newer machines.

A trend toward medium-sized dozers such as the Caterpillar D–6 appears to be developing because they cost less to purchase and to operate than the larger D–8. The smaller machine, now capable of building adequate firelines in heavy fuels, is certainly preferable because it is narrower and causes less environmental damage. There are also several entirely new makes of bulldozers that need to be evaluated.

Bulldozers continue to have an important role in constructing firelines in the forest regions where they have historically been used. Bulldozer use is expected to continue, though curtailment may occur because of concern over environmental damage. Old bulldozers and new dozers are so different, both in size class delineation and control systems, that data on fireline construction rates need to be updated. Operator skill is an important variable, too, but is very difficult to measure. It is generally recognized that the operator can also make real differences in production rates.

Bulldozers have been so successful for fireline construction that continued use is probable. To maximize efficiency in future use, information should be provided on the suitability of various machines for specific jobs. Manufacturers are continually improving dozers, primarily for earth moving. Because it is impractical to design a machine of this size and cost especially for fireline construction, current models will be used for this purpose. Therefore, we should derive performance data and operating costs in simulated fireline construction situations.

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